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Standard Specification for RAIL-STEEL DEFORMED AND PLAIN BARS FOR CONCRETE REINFORCEMENT¹

This standard is issued under the fixed designation A 616; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval.

This specification has been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This specification covers deformed and plain rail steel concrete reinforcement bars. A deformed bar is defined as a bar that is intended for use as reinforcement in reinforced concrete construction. The surface of the bar is provided with lugs or protrusions (hereinafter called *deformations*) which inhibit longitudinal movement of the bars relative to the concrete which surrounds the bars in such construction and conform to the provisions of this specification. The standard sizes and dimensions of deformed bars and their number designations shall be those listed in Table 1.

1.2 Bars are of two minimum yield levels: namely, 50 000 psi (345 MPa) and 60 000 psi (415 MPa), designated as Grade 50 and Grade 60, respectively.

1.3 Plain rounds, in sizes up to and including 2 in. (50.8 mm) in diameter, in coils or cut lengths, when specified for dowels, spirals and structural ties or supports shall be furnished under this specification in Grade 50 and Grade 60. For bending properties test provisions of the nearest smaller nominal diameter deformed bar size shall apply. Those requirements providing for deformations and marking shall not be applicable.

1.4 The weldability of the steel is not part of this specification.

NOTE 1—The values stated in inch-pound units are to be regarded as the standard.

2. Applicable Documents

2.1 ASTM Standards:

A 370 Methods and Definitions for Mechanical Testing of Steel Products²

A 700 Recommended Practices for Packaging, Marking, and Loading Methods for Steel Products for Domestic Shipment³

2.2 Military Standards:

MIL-STD-129 Marking for Shipment and Storage⁴

MIL-STD-163 Steel Mill Products Preparation for Shipment and Storage⁴

2.3 Federal Standard:

Fed. Std. No. 123 Marking for Shipments (Civil Agencies)⁴

3. Ordering Information

3.1 Orders for material under this specification shall include the following information:

3.1.1 Quantity (weight or length),

3.1.2 Name of material (rail-steel deformed and plain bars for concrete reinforcement),

3.1.3 Size and length,

3.1.4 Deformed or plain,

3.1.5 Grade,

3.1.6 Packaging (see Section 14), and

3.1.7 ASTM designation and date of issue.

¹ This specification is under the jurisdiction of ASTM Committee A-1 on Steel, Stainless Steel and Related Alloys, and is the direct responsibility of Subcommittee A01.05 on Steel Reinforcement Bars.

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² Annual Book of ASTM Standards, Parts 1, 2, 3, 4, 5, and 10.

³ Annual Book of ASTM Standards, Parts 1, 3, 4, and 5.

⁴ Available from Naval Publications and Forms Center, 5801 Tabor Ave., Philadelphia, Pa. 19120.

NOTE 2—A typical ordering design is as follows: 8000 linear ft rail-steel deformed and plain bars for concrete reinforcement, No. 8, 40 ft 0 in. long, deformed, Grade 60, in secured lifts, to ASTM A 616 dated —.

4. Material and Manufacture

4.1 The bars shall be rolled from standard section Tee rails. No other materials such as those known by the terms *rerolled*, *rail-steel equivalent*, and *rail-steel quality* shall be substituted.

5. Requirements for Deformations

5.1 Deformations shall be spaced along the bar at substantially uniform distances. The deformations on opposite sides of the bar shall be similar in size and shape.

5.2 The deformations shall be placed with respect to the axis of the bar so that the included angle is not less than 45 deg. Where the line of deformations forms an included angle with the axis of the bar of from 45 to 70 deg inclusive, the deformations shall alternately reverse in direction on each side, or those on one side shall be reversed in direction from those on the opposite side. Where the line of deformation is over 70 deg, a reversal in direction is not required.

5.3 The average spacing or distance between deformations on each side of the bar shall not exceed seven tenths of the nominal diameter of the bar.

5.4 The overall length of deformations shall be such that the gap between the ends of the deformations on opposite sides of the bar shall not exceed 12½ % of the nominal perimeter of the bar. Where the ends terminate in a longitudinal rib, the width of longitudinal rib shall be considered the gap. Where more than two longitudinal ribs are involved, the total width of all longitudinal ribs shall not exceed 25 % of the nominal perimeter of the bar; furthermore, the summation of gaps shall not exceed 25 % of the nominal perimeter of the bar. The nominal perimeter of the bar shall be 3.14 times the nominal diameter.

5.5 The spacing, height and gap of deformations shall conform to the requirements prescribed in Table 1.

6. Measurements of Deformations

6.1 The average spacing of deformations

shall be determined by dividing a measured length of the bar specimen by the number of individual deformations and fractional parts of deformations on any one side of the bar specimen. A measured length of the bar specimen shall be considered the distance from a point on a deformation to a corresponding point on any other deformation on the same side of the bar. Spacing measurements shall not be made over a bar area containing bar marking symbols involving letters or numbers.

6.2 The average height of deformations shall be determined from measurements made on not less than two typical deformations. Determinations shall be based on three measurements per deformation, one at the center of the over-all length and the other two at the quarter points of the overall length.

6.3 Insufficient height, insufficient circumferential coverage, or excessive spacing of deformations shall not constitute cause for rejection unless it has been clearly established by determinations on each lot (Note 3) tested that typical deformation height, gap or spacing do not conform to the minimum requirements prescribed in Section 5. No rejection may be made on the basis of measurements if fewer than ten adjacent deformations on each side of the bar are measured.

NOTE 3—A lot is defined as all the bars of one bar number and pattern of deformation contained in an individual shipping release or shipping order.

7. Tensile Requirements

7.1 *Grade 50 and Grade 60*—The material as represented by the test specimens shall conform to the requirements for tensile properties prescribed in Table 2.

7.2 The yield point or yield strength shall be determined by one of the following methods:

7.2.1 The yield point shall be determined by drop of the beam or halt in the gage of the testing machine.

7.2.2 When the steel tested does not have a well-defined yield point, the yield strength shall be tested by one of the methods indicated in 7.2.2.1 or 7.2.2.2.

7.2.2.1 Extension under load using dividers with an 8-in. (203.2-mm) gage length. The extension under load shall be 0.04 in. (1.02 mm) and shall be determined by scribing on the specimen an 8-in. gage length, pivoting from a

prick punch mark. The yield load shall be recorded when the total gage length under load becomes 8.04 in. (204.2 mm) as measured by the dividers.

7.2.2.2 Extension under load using an autographic diagram method or an extensometer as described in 13.1.2 to 13.1.3 of Methods and Definitions A 370. However, the extension under load shall be 0.005 in./in. of gage length (0.5 %) for Grade 60.

7.3 The percentage of elongation shall be as prescribed in Table 2.

8. Bending Requirements

8.1 The bend test specimen shall stand being bent, when at ambient temperature but in no case less than 60°F (16°C), around a pin without cracking on the outside of the bent portion. The requirements for degree of bending and sizes of pins are prescribed in Table 3.

8.2 The bend test shall be made on specimens of sufficient length to ensure free bending and with apparatus which provides:

8.2.1 Continuous and uniform application of force throughout the duration of the bending operation.

8.2.2 Unrestricted movement of the specimen at points of contact with the apparatus and bending around a pin free to rotate, or bending about a central pin on a simple span with end supports free to rotate.

8.2.3 Close wrapping of the specimen around the pin during the bending operation.

8.3 Other methods of bend testing may be used, but failure due to such methods shall not constitute a basis for rejection.

9. Test Specimens

9.1 Tension test specimens shall be full section of the bar as rolled.

9.2 The unit stress determinations on full-size specimens shall be based on the nominal bar area.

9.3 The bend test specimens shall be the full section of the bar as rolled.

9.3.1 Bend tests are not required on bars fabricated by the producer.

10. Number of Tests

10.1 For bar sizes No. 3 to No. 11 inclusive, one tension test and one bend test shall be made of each bar size rolled from each lot of

10 tons (9072 kg) or fraction thereof rolled from rails varying not more than 10 lb/yd of nominal weight.

10.2 If any test specimen develops flaws, it may be discarded and another specimen of the same size bar from the same lot of 10 tons or fraction thereof substituted.

10.3 If any tensile property of the test specimen is less than that specified in Section 7 and any part of the fracture is outside the middle third of the gage length, as indicated by scribe scratches marked on the specimen before testing, a retest shall be allowed.

11. Permissible Variations in Weight

11.1 The permissible variations shall not exceed 6 % under nominal weight. Reinforcing bars are evaluated on the basis of nominal weights. In no case shall overweight of any bar be the cause for rejection.

12. Finish

12.1 The bars shall be free from injurious defects and shall have a workmanlike finish.

12.2 Rust, seams, surface irregularities, or mill scale shall not be cause for rejection provided the weight, dimensions, cross-sectional area and tensile properties of a hand wire brushed test specimen are not less than the requirements of this specification.

13. Marking

13.1 When loaded for mill shipment, bars shall be properly separated and tagged with the manufacturer's test identification number.

13.2 Each producer shall identify the symbols of his marking system.

13.3 All bars produced to this specification, except plain round bars, which shall be tagged for grade, shall be identified by a distinguishing set of marks legibly rolled into the surface of one side of the bar to denote in the following order:

13.3.1 *Point of Origin*—Letter or symbol established as the producer's mill designation.

13.3.2 *Size Designation*—Arabic number corresponding to bar designation number of Table 1.

13.3.3 *Type of Steel*—A rail symbol indicating that the bar was produced from rail steel.

13.3.4 *Minimum Yield Designation*—For Grade 60 bars, either the number 60 or a single

continuous longitudinal line through at least five spaces offset from the center of the bar side.

14. Packaging

14.1 When specified in the purchase order, packaging shall be in accordance with the procedures in Recommended Practices A 700.

14.2 *For Government Procurement Only*—When specified in the contract or order, and for direct procurement by or direct shipment to the U.S. government, material shall be preserved, packaged, and packed in accordance with the requirements of MIL-STD-163. The applicable levels shall be as specified in the contract. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

15. Inspection

15.1 The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works that concern the manufacture of the material ordered. The manufacturer shall afford the inspector all reasonable facilities to

satisfy him that the material is being furnished in accordance with this specification. All tests and inspection shall be made at the place of manufacture prior to shipment unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

15.2 *For Government Procurement Only*—Except as otherwise specified in the contract, the contractor is responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract, the contractor may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser at the time of purchase. The purchaser shall have the right to perform any of the inspections and tests at the same frequency as set forth in this specification where such inspections are deemed necessary to assure that material conforms to prescribed requirements.

16. Rejection

16.1 Material that shows injurious defects subsequent to its acceptance at the manufacturer's works will be rejected, and the manufacturer shall be notified.

TABLE 1 Deformed Bar Designation Numbers, Nominal Weights, Nominal Dimensions and Deformation Requirements

Inch-Pound Units							
Bar Designation No. ^B	Nominal Weight, lb/ft	Nominal Dimensions ^A			Deformation Requirements, in.		
		Diameter, in.	Cross-Sectional Area, in. ²	Perimeter, in.	Maximum Average Spacing	Minimum Average Height	Maximum Gap (Chord of 12½ percent of Nominal Perimeter)
3	0.376	0.375	0.11	1.178	0.262	0.015	0.143
4	0.668	0.500	0.20	1.571	0.350	0.020	0.191
5	1.043	0.625	0.31	1.963	0.437	0.028	0.239
6	1.502	0.750	0.44	2.356	0.525	0.038	0.286
7	2.044	0.875	0.60	2.749	0.612	0.044	0.334
8	2.670	1.000	0.79	3.142	0.700	0.050	0.383
9	3.400	1.128	1.00	3.544	0.790	0.056	0.431
10	4.303	1.270	1.27	3.990	0.889	0.064	0.487
11	5.313	1.410	1.56	4.430	0.987	0.071	0.540

SI Units							
Bar Designation No. ^B	Nominal Weight, kg/m	Nominal Dimensions ^A			Deformation Requirements, mm		
		Diameter, mm	Cross-Sectional Area, cm ²	Perimeter, mm	Maximum Average Spacing	Minimum Average Height	Maximum Gap (Chord of 12½ percent of Nominal Perimeter)
3	0.560	9.52	0.71	29.9	6.7	0.38	3.5
4	0.994	12.70	1.29	39.9	8.9	0.51	4.9
5	1.552	15.88	2.00	49.9	11.1	0.71	6.1
6	2.235	19.05	2.84	59.8	13.3	0.96	7.3
7	3.042	22.22	3.87	69.8	15.5	1.11	8.5
8	3.973	25.40	5.10	79.8	17.8	1.27	9.7
9	5.059	28.65	6.45	90.0	20.1	1.42	10.9
10	6.403	32.26	8.19	101.4	22.6	1.62	11.4
11	7.906	35.81	10.06	112.5	25.1	1.80	13.6

^A The nominal dimensions of a deformed bar are equivalent to those of a plain round bar having the same weight per foot as the deformed bar.

^B Bar numbers are based on the number of eighths of an inch included in the nominal diameter of the bars.

TABLE 2 Tensile Requirements

	Grade 50	Grade 60
Tensile strength, min, psi (MPa)	80 000 (550)	90 000 (620)
Yield strength, min, psi (MPa)	50 000 (345)	60 000 (415)
Elongations in 8 in. or 203 mm, min, %		
Bar No.		
3	6	6
4, 5, 6	7	6
7	6	5
8	5	4.5
9, 10, 11	5	4.5

TABLE 3 Bend Test Requirements

Bar Designation No.	Pin Diameter for ^A Bend Tests d = nominal diameter of specimen	
	Grade 50	Grade 60
3, 4, 5, 6	$6d$	$6d$
7, 8	$6d$	$6d$
9, 10	$8d$	$8d$
11	$8d$ (90 deg)	$8d$ (90 deg)

^A Test bends 180 deg unless noted otherwise.

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